Surgery in management of snake envenomation in children

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Background: **Snakebite is common in children especially in the developing countries. This study was undertaken to determine the role of surgery in the treatment of venomous snake bite in pediatric patients.**

Methods: **The clinical data of 58 pediatric patients aged 0-16 years who had been treated for venomous snakebite from January 1999 to December 2008 were analyzed.**

Results: **Of the 58 patients, 43 (74.6%) were male. Peak age incidence was around 2-3 years (28.8%). The majority of envenomations occurred in the summer and rainy seasons, especially in the latter, during flooding. The bites occurred during 6 pm to 12 pm in 27 patients (49.0%). The main bite site was the lower extremities in 49 patients (83.9%). The main species of the snake were Malayan pit viper (*Calloselasma rhodostoma*) in 28 patients (47.5%) and cobra (*Ophiophagus hunnah* or *Naja spp.*) in 21 patients (35.6%). Soft tissue necrosis occurred more in cobra bites (47.6%) than viper bites (3.6%). The most common organism identified in necrotic tissue was *Morganella morgagnii*. Four patients with cobra bite had respiratory failure that required ventilatory support. Compartment syndrome was suspected in 2 patients. Surgical intervention was necessary in 13 patients. Most procedures involved serial wound debridement, followed by skin grafting. One case needed a toe amputation because of necrosis. The average length of hospital stay in patients who needed surgical management was 18.8 days (range: 12.1-25.5 days). There were no mortalities.**

Conclusions: **Surgery plays an important role in the management of snakebite patients, especially for those with cobra bite with tissue necrosis.**

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Brief report

Introduction

Snakebite is a common problem in the pediatric age group, especially in rural areas of developing countries.[1,2] Snakebite venom produces various toxic effects from local tissue damage to systemic manifestations. Although most patients can be treated with specific antivenoms, local complications such as soft tissue necrosis and compartment syndrome remain problematic.[3] Surgical management of snakebite in certain cases has been practiced for many years. Surgical approaches to viper envenomation, for example, vary from surgical debridement of the bite site to fasciotomy and digital or limb amputation.[3,4] In southern Thailand, resident snakes that are major causes of envenomation include Malayan pit viper (MPV, *Caloselasma rhodostoma*) and spitting cobra (*Naja spp.*).[5-7] Extensive soft tissue necrosis can result from the bites of any of these snakes.

The main objective of this study was to review a single institutional experience in the management of snakebites in the pediatric age group with an emphasis on the role of surgical management.

Methods

All pediatric patients aged 0-16 years who had been hospitalized for snakebite at Songklanagarind Hospital, the major referral center in southern Thailand, from January 1999 to December 2008 were identified. Their medical records were reviewed under the approval of the institutional ethics committee of the hospital. Data were analyzed with regard to demographics, the

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type of location where the patients were bitten, the type of snake, the anatomic site of the bite, the season when the bite occurred, the length of time between the bite and the admission, the need for an antivenin, and complications and type of surgical treatment if surgical intervention was given. The genus of snake was verified on the basis of an account by a reliable witness or the presentation of the snake body. If the biting species is unknown, recognition of the emerging pattern of symptoms, signs and results of laboratory test may also suggest which species is responsible. Patients who had been treated at other hospitals and referred to our clinic after 48 hours were excluded from this study.

The clinical management generally followed the WHO/SEARO guidelines for the clinical management of snake bites in Southeast Asia.[8,9] In brief, a patient was examined for vital signs and clinical signs of systemic toxicity, focusing on hematologic, neurologic and respiratory manifestations. Tests including venous clotting and complete blood count were performed for all patients. Coagulation tests including prothrombin time and partial thromboplastin time were performed as a confirmatory test when the venous clotting test was abnormal. Antivenom was administered when there were clinical signs and laboratory evidence of systemic envenomation or severe local tissue damage. The patients who were suspected of cobra bite and those with viper bite who had abnormal venous clotting time were hospitalized. Mechanical ventilatory support was used in patients with respiratory failure.

Soft tissue necrosis (STN) was defined as ischemic necrosis penetrating deeply into the subcutaneous tissue that required surgical intervention.

Statistical analysis was made using the Strata software (Version 6, Strata Corporation, College Station, TX, USA). Descriptive data were presented as mean, percentage and range. Univariate comparisons used unpaired Student's *t* test or the Chi-square test when appropriate. Multivariate association study used multiple logistic regression analysis. Statistical significance was considered when a *P* value was less than 0.05.

Results

In the 10-year period, 58 patients, 43 males and 15 females, were admitted to our institute after a diagnosis of snakebite. Twenty-eight patients were bitten by MPV, 21 by cobra, and 9 by other or unidentified snakes. Most of the patients (49 patients) were bitten at the lower extremities.

The highest incidence of snakebites was seen between February and August, which is the summer and rainy seasons in southern Thailand. By dividing the time of a day into four 6-hour periods, we observed most patients were attacked between 6 pm and midnight, a peak period which was more apparent in MPV bitten patients. Interestingly, the incidence of cobra bites within the shelter of a house (75%) was significantly higher than that of bites of MPV and other snakes (14%) ($P<0.01$). The time interval between being bitten and arrival at our hospital ranged from less than 15 minutes to 24 hours.

The average length of hospital stay of our patients was 7.6 days. The length of stay in patients with cobra bites (13.2 days) was significantly longer than that in patients bitten by MPV (3.5 days) ($P<0.01$). The hospital stay of patients who needed surgical management was 18.8 days (12.1-25.5 days). Respiratory failure occurred in 8 patients, of whom 7 were bitten by cobra and 1 by unidentified snake. Antivenom agents were given to 22 patients, which included 11 of the 28 patients with MPV bite, 10 of the 21 patients with cobra bite, and 1 of the 9 patients bitten by other snakes. The average number of antivenin doses was not different between patients with cobra bite (2.0 doses) and those with MPV bite (1.9 doses).

STN occurred in 10 patients with cobra bite (47.6%), 1 with MPV bite (3.6%), and 2 with unidentified snakebites ($P<0.01$). The study did not show any significant association between STN and duration from the scene to the hospital (Table). The occurrence of respiratory failure was significantly associated with STN and cobra genus of snake. Multivariate analysis showed a significant association between administration of antivenom and the occurrence of STN, independent of the snake genera ($P<0.01$).

In all patients with STN, the necrotic area involved an area or limb compartment adjacent to the bite sites (Fig.). Seven patients underwent serial debridement followed by skin grafting, and 5 underwent single debridement only. One patient who was bitten on the foot developed toe gangrene necessitating an amputation. Two patients who were bitten on a lower limb were suspected to have compartment syndrome because of severe swelling and poor palpable pulses; however, when their compartment pressure was

Table. Comparisons between snakebite patients with and without soft tissue necrosis (STN)

	no STN (n=45)	STN (n=13)	P value
Snake type: cobra	8 (17.8%)	10 (76.9%)	<0.01*
Median time to hospital (h)†	1 (0.25-24)	1 (0.25-3)	0.47‡
Antivenom used	13 (28.9%)	10 (76.9%)	<0.01*
Respiratory failure	2 (4.4%)	6 (46.2%)	<0.01
Positive wound culture	0 (0%)	10 (76.9%)	<0.01

*: independent factors associated with STN on a logistic regression model; †: presented as median (range); ‡: comparison of means.

Fig. Left foot of a 5-year-old boy who was bitten by a cobra; **A:** On day 1, only swelling and minimal inflammation were observed at the dorsum of the foot (arrow indicates fang marks); **B:** On day 3, his leg developed blistering and extensive soft tissue necrosis; **C:** After serial debridement on day 10; **D:** The wound was covered with meshed skin graft derived from his own prepuce on the second week.

carefully measured, a fasciotomy could be safely performed. Microbiological studies reported positive tissue and/or blood culture in 10 patients. Most patients with positive culture showed mixed organisms, with the most common bacteria being *Morganella morganii, Proteus vulgaris* and *Shewanella spp.* All patients were alive.

Discussion

Snake bites remain a problem in the rural areas of developing countries.[2] In Thailand, a large center in Bangkok reported snake bites in 50 children aged less than 15 years in a 10-year period.[10] Consistent with other reports, our study found the same biting epidemiology that most bites happened in the afternoon and evening[10,11] and the peak incidence of bites occurred in the rainy season. Moreover, most cobra bites occurred within the shelter of a house, typically when a cobra hided under a bed or a sofa and attacked the child in the dark while he or she was entering the room or sleeping in their bed. In the case of MPV, bite usually occurred in a garden or the backyard of a house.

The role of a surgeon in evaluating a patient with snake envenomation begins at arrival at the emergency room and wound examination is the primary task of a surgical team. It should be noted that despite a bite site showing fang marks surrounded by only signs of inflammation at the beginning, adjacent areas can develop extensive necrosis and compartment syndrome up to several days following the bite. As STN occurred in about half of the patients with cobra bite in our series and its incidence ranged from 27% to 76% in other reports,[3,7,11] we suggest early surgical consultation for all cases of cobra bite. The results of our study suggested that in-hospital observation is recommended for at least 72 hours for patients with cobra bite, whereas a patient with an MPV bite but no complications can be discharged within a day. In patients with cobra bite, even if there is no STN that needs surgery within 3 days, a reassessment after a week is needed to exclude delayed necrosis.[11] As 20% of our patients showed positive wound culture and most of them belonged to the STN group, we recommend that if STN develops and there is evidence of secondary infection, broad spectrum antibiotics including anti-anaerobic agents should be administered until the wound is clear of necrotic tissue. In addition, tetanus prophylaxis should be considered according to the immunization background of each patient. All patients with soft tissue necrosis should receive early antivenom therapy as this may reduce the severity and extent of the necrotic area.[9,11]

Reports suggest early debridement of the bite area in order to limit the extent of local envenomation;[12-14] however, we are not in total agreement with this practice. In our experience, surgery can safely be delayed until a patient has recovered from the hematologic and neurologic toxicity, and it usually takes 48-72 hours. During this period, demarcation of the necrotic area will become clearer and the patient will have a decreased risk of excessive hemorrhage from surgery. A new technique of vacuum-assisted wound dressing was used in our recent cases, following adequate debridement, and we have found that this technique reduces the frequency of wound dressing changes. Wound resurfacing by skin graft can be considered if appropriate when the granulation tissue has begun to grow at day 7-10.

Because compartment syndrome may cause complications through tissue ischemia and threatened limb survival, it is advisable to carefully observe a bitten extremity for its perfusion. Although compartment pressure cannot be easily measured at bedside in children, the surgeon should be aware that fasciotomy is rarely indicated for them[3] and should not be performed without adequate documentation of compartment syndrome. In addition, the surgeon should be aware of the possibility of rhabdomyolysis and/or renal complications in cases of sea snakes and Russel's viper envenomation.[9]

In summary, approximately 20% of the patients had STN which required at least one surgical procedure. The surgical roles in these patients included wound monitoring, necrotic tissue debridement and cutaneous resurfacing at the right time.

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